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(54) Abstract Title
Liquid spray nozzle for coating a strip of material

(57) A spray nozzle assembly (11) for spraying a liquid coating onto a strip of material (5), and particularly for spraying a parting liquid onto an aluminium foil substrate, is provided with a central liquid nozzle (28) connected to a liquid feed pipe (27) and having a tubular outlet channel (29). The outlet channel (29) leads by an air feed channel (31), of which the outlet aperture (32) is positioned annularly around the outlet channel (29) and discharges into a hood (33) acting as a fan-jet distributor with a slit-shaped outlet aperture (18). The quantity of liquid applied can be steplessly regulated over a very wide range and using the liquid pressure alone. The outlet channel (29) of the liquid nozzle (28) has an internal diameter not exceeding 0.3 mm and a length of over thirty times the internal diameter. A plurality of nozzles are mounted on a cross-beam and synchronously pivoted about a vertical axis to adjust the coverage according to delivery pressure.

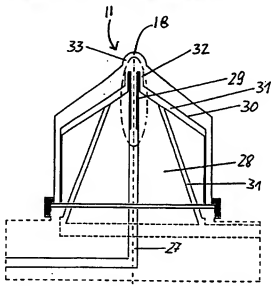

Fig.5

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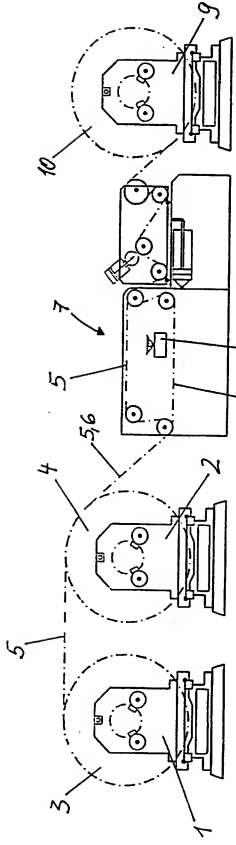

Fig. 1

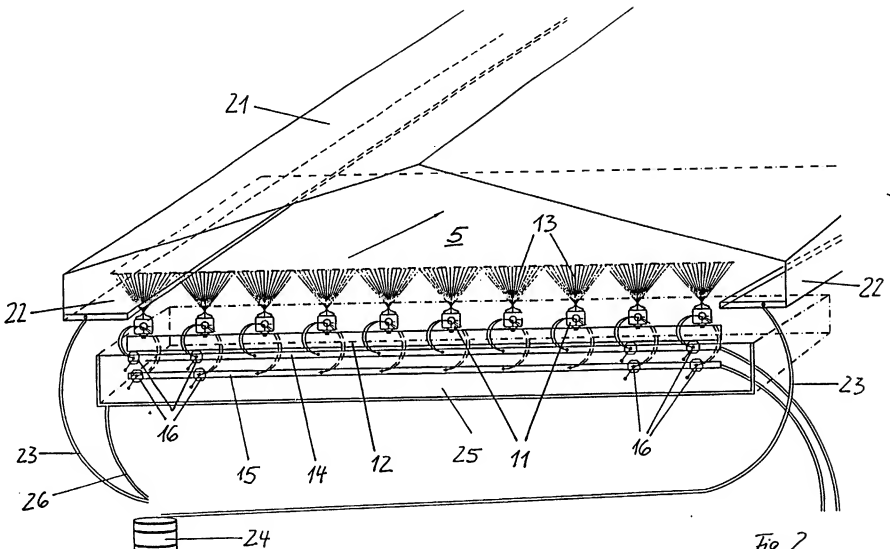

Fig. 2

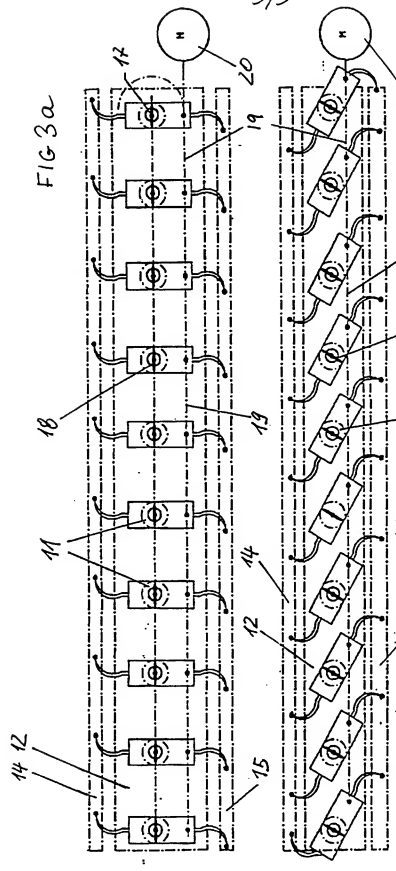

Fig. 3b

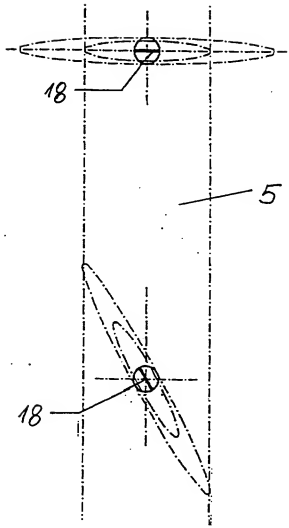

FIG 4a

Fig. 4b

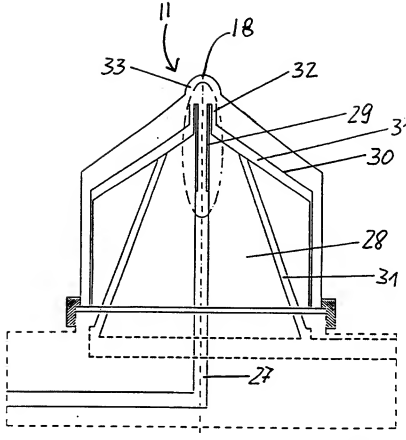

Fig. 5

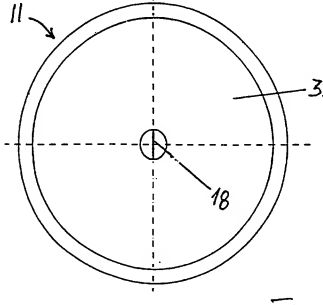

Fig. 6

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TITLE

Liquid Spray Nozzle for Coating a Strip of Material

This invention relates to a liquid spray nozzle and liquid spray system for spraying a coating liquid onto a substrate such as a strip of material. This invention is useful for spraying a parting liquid onto an aluminium foil.

In the production of extremely thin aluminium foils two strips of foil material have to be guided one above the other through a rolling mill in order to obtain the desired foil thicknesses of up to 6 μm. For this purpose the rolling process is preceded by that of winding a lap roll from two foils situated one above the other in a so-called Doppler machine. The two foils are then detached from each other on a separating machine after the final rolling operation and wound up to form lap rolls.

To ensure that the two foil strips will not become welded together in the rolling process a parting liquid such as petroleum or kerosene with suitable additives is sprayed onto the inside of one of the two strips during the operation and in the course of the doubling operation. After the separation the lap rolls are heated in annealing furnaces to cause the parting liquid to volatilise.

The parting liquid is sprayed on by a spraying system consisting of a number of spray nozzles distributed over the width of the strip. As is known, use is made of binary nozzles from which the parting liquid is sprayed by compressed air. It has nevertheless been found in practice

that the known binary nozzles are incapable of spraying on a sufficiently controlled quantity of parting liquid with the required uniformity.

One object of this invention is to provide a spray nozzle capable of applying a parting liquid with the necessary uniform diffusion pattern in a quantity which is adjustable over a wide range. A further object of this invention is to provide a spraying system for applying parting liquid using a spray nozzle according to this invention.

According to this invention there is provided a spray nozzle assembly for spraying a liquid coating onto a strip of material, the nozzle assembly comprising a central liquid nozzle connected to a liquid feed duct, the nozzle having a tubular outlet channel and an air feed channel of which the outlet aperture is positioned in an annular configuration around the said nozzle outlet channel, a hood forming a flat or fan-jet distributor and having a slit-shaped outlet aperture into which the said nozzle outlet channel and the air feed channel feed, the said nozzle outlet channel having a maximum internal diameter of 0.3 mm and a length greater than thirty times the internal diameter.

According to this invention there is also provided a spray system for spraying a coating liquid onto a strip of material, primarily for spraying a parting liquid onto an aluminium foil substrate, the system comprising a plurality of spray nozzles positioned equal distances apart and extending across the working width of the strip of material.

The spray nozzles according to the invention enable the parting liquid to be uniformly distributed with the transport medium at a constant pressure of 1 bar. The quantity applied can be steplessly adjusted by

means of the pressure of the liquid over a very wide range, for example 300-6000 cm^3/hour. This obviates eddying and ensures that only the actual apportioned quantity per square metre is applied without any appreciable losses and without dripping.

Since it is applied without any appreciable losses no costly suction equipment has to be installed in order to protect the place of work or the environment. Costs are also saved by the fact that the largely loss-free application reduces the consumption of parting liquid.

This invention is further described with reference to an embodiment as an example and shown on simplified lines in the drawings, wherein:

Figure 1 shows a schematic diagram of a Doppler machine with a spraying system,

Figure 2 shows a cross section through a spraying system,

Figures 3a and 3b show a schematic plan view showing the angular adjustment of the nozzle, between two limit positions,

Figures 4a and 4b show the diffusion pattern resulting from two different angular nozzle settings,

Figure 5 shows an enlarged cross section through a spray nozzle, and

Figure 6 shows a plan view of the nozzle.

The Doppler machine shown in Figure 1 of the drawings has two winding feed devices 1,2, which support suspended lap rolls 3 and 4 respectively, consisting of a thin aluminium foil. From the two devices 1,

2 which are arranged in succession in the direction of motion of the strip of material, strips of foil 5 and 6 are drawn off and are conveyed one above the other to a device 7 for the spray application of a parting liquid, such as petroleum or kerosene with suitable additives. Inside the spray device 7 the strips of foil 5, 6, are guided in parallel and at a certain distance apart. A spraying system 8 is provided between the two strips which sprays the liquid from below against the inside or lower surface of the upper strip of foil 5. The two strips of foil 5, 6 are then once again brought together, one over the other, and conveyed to a subsequent winding-up device 9 where they are wound up together to form a lap roll 10.

The spraying system 8 is shown to a larger scale in Figure 2 and comprises a row of individual nozzles 11 positioned across the strip of material and spaced at intervals of about 160 mm on a common supporting traverse 12 in such a way that the outlet apertures are at the top so that the lower side of the upper strip of material 5 is sprayed with parting liquid 13. The nozzles 11 are connected to common distributor tubes 14, 15, from which they are supplied with parting liquid (distributor tune 14) and air (distributor tune 15). The distributor tubes 14, 15 are dimensioned to prevent any substantial pressure losses from occurring therein when the maximum quantity of air and liquid is being sprayed. This ensures that the same liquid and air pressure will prevail in all the nozzles 11, so that the same quantity of parting liquid 13 is emitted. In order to enable the spraying system 8 to be set to different operating widths the two outer nozzles 11 on the respective sides of the machine

can be individually disconnected by means of valves 16 from the respective distributor pipes 14, 15.

As may be seen from Figure 3, each nozzle 11 is mounted on the supporting traverse 12 in such a way as to be pivotable about a central axis 17, so that a slit-shaped outlet aperture 18 can be adjusted in position in relation to the direction of travel of the strip of material. The said adjustment is effected by means of an adjusting bar 19 which extends across the working width and to which each nozzle 11 is linked by the nozzle housing. The adjusting bar 19 is movable transversally by means of a side mounted motor 20, in which process each nozzle 11 is rotated about the vertical rotation axis 17. The adjusting range of the slit-shaped outlet aperture 18 of each nozzle 11 in relation to the direction of motion of the strip of material amounts preferably to at least 45° and preferably to 60°, from the zero position shown in the upper view in Figure 3, in which the slip-shaped outlet apertures 18 are perpendicular to the said direction. By rotating the nozzles 11 the width of the spray jet can thus be adjusted from about 300 mm to about 160 mm without altering the distance from the nozzles 11 to the strip of material 5. The effect of rotation of the nozzles 11 by 60° from the zero position is shown in Figure 4. The diffusion pattern changes in the rotation in such a way that the apportioned quantity is sprayed onto a smaller strip width. By the angle adjustment the jet width dependent on the quantity of liquid applied by each nozzle 11 can be adjusted in such a manner that the jets of the two adjacent nozzles 11 do not overlap. Overlapping between two jets would cause eddying which would detract from the evenness of application. In

operation the nozzles 11 are set to ensure that their respective zones of application just touch. The diffusion pattern of each nozzle can thus be adapted to any desired quantity applied per unit time providing for an even and eddy-free application.

As shown in Figure 2, the strip of material 5 is surmounted by a hood 21 which slants down from an apex to the edges of the strip 5 and which in the event of a tear in this latter will ensure that no parting liquid emerges from the spray device 7. On each of the two edges of the strip of material the hood 21 has a drip channel 22 extending along the spraying zone in the direction in which the strip of material moves. The drip channels 22 collect the parting liquid not applied to the strip 5 and convey same through pipes 23 to a collecting tank 24. Underneath the nozzle connection a collecting trough 25 is provided by which the parting liquid dropping down is intercepted and likewise conveyed through a pipe 26 to the collecting tank 24.

In Figures 5 and 6 a single nozzle 11 is shown to larger scale. The nozzle 11 contains a central liquid nozzle 28 connected to liquid feed pipe 27 and having a tubular outlet channel 29. Around the liquid nozzle 28 an air nozzle 30 is provided which contains an air feed channel 31 of which the outlet aperture 32 is positioned in annular configuration around the outlet channel 29 of the liquid nozzle 28. The outlet channel 29 of the liquid nozzle 28 and the air feed channel 31 lead into a hood 33 with a slit-shaped outlet aperture 18 acting as a flat-jet distributor.

An important feature of this invention is the fact that the outlet channel 29 of the liquid nozzle 28 has an internal diameter of less than

0.3 mm, preferably about 0.1 to 0.2 mm, and a length of over 30 times the internal diameter thereof. In the example shown the length of the outlet channel 29 is about 90 times the internal diameter which is about 0.2 mm. The outlet channel 29 thus formed operates over the length thereof as a uniform throttle. The flow of liquid thus takes an unimpeded laminar form and is sprayed into the air jet.

The spray nozzle 11 thus constructed can be operated at a constant air pressure, the quantity of liquid emitted being steplessly regulated by the liquid pressure alone. The pressure of the liquid can be adjusted to between 0.25 bar and a maximum of 15 bar. With such pressure a throughput of between 300 cm^3/hour and up to 6000 cm^3/hour is obtainable. The width of the jet of liquid emerging from the slit-shaped outlet aperture 18 varies over this pressure range from 160 to 300 mm. This is corrected by rotating the nozzle 11 and thus altering the angle of the outlet aperture 11 in relation to the strip of material. With a maximum throughput of liquid a rotation of the nozzle 11 through an angle of 60° causes the said nozzle 11 once again to act on a width of about 160 mm over the strip, so that no eddying is caused by adjacent jets crossing over and interfering.

CLAIMS

1. Spray nozzle assembly for spraying a liquid coating onto a strip of material, the nozzle assembly comprising a central liquid nozzle connected to a liquid feed duct, the nozzle having a tubular outlet channel and an air feed channel of which the outlet aperture is positioned in an annular configuration around the said nozzle outlet channel, a hood forming a flat or fan-jet distributor and having a slit-shaped outlet aperture into which the said nozzle outlet channel and the air feed channel feed, the said nozzle outlet channel having a maximum internal diameter of 0.3 mm and a length greater than thirty times the internal diameter.

2. Spray system for spraying a coating liquid onto a strip of material, primarily for spraying a parting liquid onto an aluminium foil substrate, the system comprising a plurality of spray nozzles according to Claim 1 positioned equal distances apart and extending across the working width of the strip of material.

3. Spray system according to Claim 2, wherein each nozzle is mounted on a common support transverse to the direction of motion of the strip so as to be rotatable about an axis perpendicular to the plane of the strip of material.

4. Spray system according to Claim 3, wherein an adjustment drive means is provided for the synchronous rotation of all the nozzles about

their axes.

5. Spray system according to any one of Claim 2 to 4, wherein the nozzles are connected to common distributor pipes for feed of liquid and air, said pipes being dimensioned whereby no appreciable pressure losses occur across the working width.

6. Spray system according to any one of Claims 2 to 5, wherein the emission of liquid from the nozzles is at constant air pressure and is regulated by the pressure of the liquid.

7. A spray nozzle for the purposes set forth herein constructed and arranged to function as described herein and exemplified.

8. A spray nozzle assembly or system for coating a substrate with a liquid as herein described and illustrated with reference to the drawings.

The Patent Office

Application No:	GB 9813430.7	**Examiner:**	J.H.Warren
Claims searched:	1-8	**Date of search:**	7 October 1998

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): B2F

Int Cl (Ed.6): B05B 1/04, 7/02, 7/04, 7/06

Other: ONLINE Databases: WPI, CLAIMS and JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 0 959 380	AUTO RESEARCH - see nozzle 115, surrounding air nozzles 121, cap 124 with slit 125.	
A	GB 0 509 541	DE VILBISS - see concentric nozzles 1 and 3 and slit nozzle 9.	
A	GB 0 337 064	BUCHANAN - see nozzles 9, 11 and 27	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.